

## Preface

The fabrication of a definitively wide range of products requires the shaping of metals. This simple statement justifies why the scientific community working on metal forming is enlarging every year all over the world.

In the last years Metal Forming Conference series has became a referring point both for researchers and industries, a forum in which ideas and innovative approaches are shared. The wideness of the considered topics has determined an always growing interest in the Conference.

This volume of Key Engineering Materials contains the papers presented at the 15<sup>th</sup> Metal Forming International Conferences, which was held in Palermo, Italy on September 21-24. This conference was the 15<sup>th</sup> in a series started in 1974 by the Akademia Górnictwa-Hutnicza in Kraków. From 1994 to 2010 the Conference was organized biennially, jointly with the University of Birmingham in United Kingdom. In 2010 the latter was replaced, as co-organizer, by University of Toyohashi (Japan). In 2012 Metal Forming Conference was organized again in Krakow by the Akademia Górnictwa-Hutnicza; in such occasion for the first time the organization team, made also by University of Toyohashi, was completed by University of Palermo (Italy). After the 2014 edition of the Conference organized in Palermo, the conference will take place again in Krakow, Poland.

In this volume about 160 papers from more than 20 countries are contained, representing an overall description of the state of the art in metal forming all over the world. Technologies, processes, materials and approaches are described and compared. New trends and interests are shown starting from the new advances in the modeling field, looking at process optimization strategies and considering issues as sustainability. Properties of final products are predicted with the aim to match requirements and specifications, determining appropriate sets of process parameters. Advanced materials such titanium and magnesium alloys are widely considered and investigated.

Finally the editors would like to express their gratitude to the reviewers of the submitted papers, as well as to the Members of the Scientific and Steering Committees of the Conference, for all their work and support, which were very helpful in determining the high scientific level of the Conference. We were pleased to welcome in Palermo every participant of the 15<sup>th</sup> Metal Forming Conference and we hope that the discussions and ideas sheared during the Conference together with this volume of proceedings will be effective starting points for further advances in the field of Metal Forming.

Fabrizio Micari, Livan Fratini  
Università degli Studi di Palermo, Italy

## STEERING COMMITTEE

Maciej Pietrzyk	Akademia Górnictwa – Hutnicza, Kraków, PL
Peter Hartley	University of Birmingham, UK
Joanguo Lin	Imperial College, London, UK

## International Scientific Committee

Yohei ABE	Toyohashi University of Technology, Japan
Taylan ALTAN	Ohio State University, USA
Mahammad BAKHSI-JOOYBARI	Babol Noshirvani University of Technology, Iran
Dorel BANABIC	University of Cluj Napoca, Romania
Paolo BARIANI	University of Padova, Italy
Wang BAOYU	University of Science and Technology Beijing, China
Alan N. BRAMLEY	University of Bath, UK
Stefania BRUSCHI	University of Padova, Italy
Bruno BUCHMAYR	University of Leoben, Austria
Jian CAO	Northwestern University, USA
Elisabetta CERETTI	University of Brescia, Italy
Jean-Loup CHENOT	Cemef, France
Jose M.A. Cesar DE SA	University of Porto, Portugal
Didier Claude FARRUGIA	Corus Research, UK
Luigino FILICE	University of Calabria, Italy
Filippo GABRIELLI	Università Politecnica Delle Marche, Italy
Lander GALDOS	University of Mandragora, Spain
Jean-Claude GELIN	Ensmm Besancon, France
Claudio GIARDINI	University of Bergamo, Italy
Peter GROCHE	Tu Darmstadt, Germany
Zbigniew GRONOSTAJSKI	Politechnika Wrocławska, Poland
Isabel GUTIERREZ	Centre of Studies And Technical Research, Spain
Anne Marie HABRAKEN	University of Liege, Belgium
Gerhard HIRT	Rwth Aachen, Germany
Peter Damian HODGSON	Deakin University, Australia
Yong-Taek IM	Kaist, Korea
Jack JESWIET	Queen's University, Canada
Mansoo JOUN	Gyeongsang National University, Korea
Rudolf KAWALLA	Tu Bergakademie Freiberg, Germany
Matthias KLEINER	Universität Dortmund, Germany
Andrzej KOCANDA	Politechnika Warszawska, Poland
Reiner KOPP	Rwth Aachen, Germany
Toshihiko KUWABARA	Tokyo University Of Agriculture And Technology, Japan
Karl KUZMAN	University Of Ljubljana, Slovenia
Lucian LAZARESCU	Technical University Of Cluj-Napoca, Romania
Hui LONG	The University Of Sheffield, UK
Janusz ŁUKSZA	Agh University Of Science And Technology, Poland
Tomoyoshi MAENO	Toyohashi University Of Technology, Japan
Ken-Ichi MANABE	Tokyo Metropolitan University, Japan
Elizabeth MASSONI	Cemef, France
Ryo MATSUMOTO	Osaka University, Japan
Marion MERKLEIN	University Erlangen-Nuremberg, Germany
Wojciech Zbigniew MISIOŁEK	Lehigh University, USA
Michele MONNO	Politecnico di Milano, Italy
Pierre MONTMITTONET	Cemef, France
Ken-ichiro MORI	Toyohashi University Of Technology, Japan
Masaaki OTSU	University Of FUKui, Japan
Zbigniew PATER	Politechnika Lubelska, Poland
Pat PHELAN	University Of Limerick, Ireland
Varunee PREMANOND	King Mongkut's University of Technology Thonburi, Thailand
Yi QUIN	University of Strathclyde, Scotland, UK
Tomaz RODIC,	University Of Ljubljana , Slovenia
Andrzej ROSOCHOWSKI	University of Strathclyde, Scotland, UK

Ivo <b>SCHINDLER</b>	Vsb - Technical University Of Ostrava, Czech Republic
Raijv <b>SHIVPURI</b>	Ohio State University, USA
Erman <b>TEKKAYA</b>	University of Dortmund, Germany
Hiroshi <b>UTSUNOMIYA</b>	Osaka University, Japan
A.H. <b>VAN DEN BOOGAARD</b>	University of Twente, The Netherlands
Frank <b>VOLLERTSEN</b>	Bias, Germany
Robert H. <b>WAGONER</b>	Ohio State University, USA
Philip J. <b>WITHERS</b>	University of Manchester, UK
Roger N. <b>WRIGHT</b>	Rensselaer Polytechnic Institute, USA
Fusahito <b>YOSHIDA</b>	Hiroshima University, Japan

## **CONFERENCE CHAIRS**

Fabrizio Micari	University of Palermo, Palermo, IT
Livan Fratini	University of Palermo, Palermo, IT
Jan Kusiak	Akademia Górnictwa – Hutnicza - Kraków, PL
Janusz Majta	Akademia Górnictwa – Hutnicza - Kraków, PL
Danuta Szeliga	Akademia Górnictwa – Hutnicza - Kraków, PL
Ken—ichiro Mori	Toyohashi University of Technology, Toyohashi, JP

## **Local Organizing Committee**

Fabrizio Micari  
 Livan Fratini  
 Rosa Di Lorenzo

## **Conference Secretary**

Roberto Licari  
 Dorotea Contorno



Akademia Górniczo-Hutnicza, Kraków, Poland



University of Palermo, Palermo, Italy



Toyohashi University of Technology, Japan